MIT Sea Grant
Spring 1984

Quarterly Report

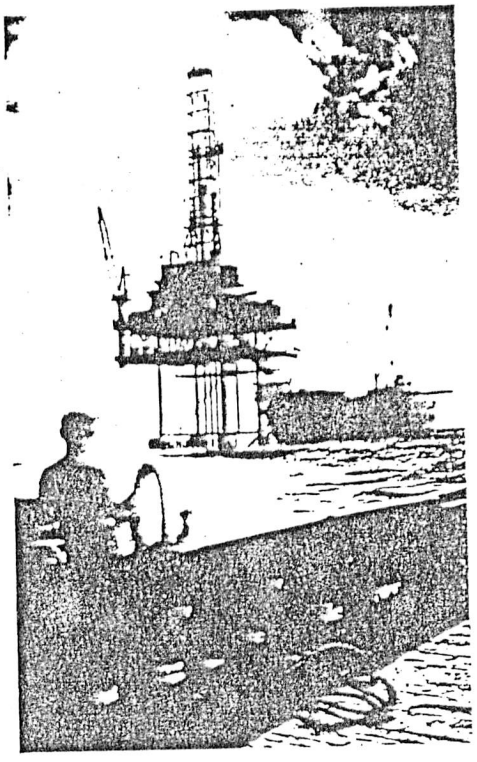
MIT Sea Grant Receives New Two-year Award

Congress started up the Sea Grant Program over two decades ago to encourage greater use, coupled with sound management, of ocean and coastal resources. Like its predecessor Land Grant, the Program was based in US universities, principally in states bordering the ocean or Great Lakes. The legislation establishing Sea Grant offered partial funding through a federal grant, with the requirement that each program match that support by more than a third from non-federal sources including industry, private foundations, state and local governments, and universities. The matching fund concept has ensured the active participation and cooperation of those people who have ultimately used Sea Grant research. Early and ongoing involvement of users has been a key reason that Sea Grant's research has been so relevant and practical. Small companies without the financial resources for extensive research and development have been able to cooperate with university faculty and students to develop profitable and beneficial technologies; large industries have found a common ground to share information and look long-term at ways of producing more food and energy from the vast resources of the oceans; local and state governments have helped to create data bases and documents which helped to make balanced economic and environmental decisions on land use.

As of July of this year, with a new, two-year $3.4 million award from the National Oceanic and Atmospheric Administration (NOAA) through the Department of Commerce, the Institute begins its fifteenth year as part of the Sea Grant network. For the first fiscal year, 1984-85, MIT has $1.5 million in matching funds from a variety of sources. Sea Grant will emphasize research in four major categories: Offshore (geotechnical, structures, and hydrodynamics), unmanned, underwater vehicles, coastal processes, and biotechnology and living resource development. Advisory services and education projects will complement the research, seeking ways to transmit results as efficiently as possible to the broadest number of people.

The Marine Industry Advisory Service Collegium, a partnership of member companies and government organizations, will offer four workshops this year for researchers and users to meet and discuss current work and its future applications. Through another advisory service arm, the Massachusetts Marine Liaison Service (MMLS), professional fishermen will take part in a State and Sea Grant sponsored educational program at the Massachusetts Maritime Academy. MMLS will also continue to manage the Center for Fisheries and Engineering Research which uses the testing facilities at the National Ship Research Development Center (NSRDC) at the David Taylor Model Basin in Bethesda, Maryland. Through the Center, researchers from MIT and other academic institutions, state agencies, and gear manufacturers can make use of the NSRDC's large-scale and finely tuned towing tank and circulating water channel. (See *Quarterly Report*, Summer 1982).

Undergraduate Research Opportunities will be made available, as they have in the past, through Sea Grant's education program, while work continues to complete a series of marine science teaching modules with the New Bedford School system. Details on all Sea Grant and other marine-related activities at MIT, or research at any of the 31 Sea Grant programs are available through the Sea Grant Information Center, a small reference facility which houses reports, periodicals and has access to a national Sea Grant data base.



In this issue

Help from Sharks in the Fight Against Cancer

Few people would call sharks man's best friend. Indeed, they are quite likely to strike terror into the hearts of most of us. Yet Sea Grant research at MIT indicates that these sometimes fierce, and often maligned fish, may help fight cancer. Professor Robert Langer and graduate student Anne Lee of MIT have found that a protein extract in the smooth, elastic skeletons of these primitive creatures has the beneficial effect of stopping the growth of some tumors in laboratory animals.

Sharks, which have remained largely untouched by the process of evolution for millions of years, have a skeletal structure which is principally cartilage, rather than the hard bone found in most animals. Curiously sharks themselves have a remarkably low incidence of cancer. According to Langer and Lee an extract from this cartilage may be the reason for the low cancer rate and shows promise as an inhibitor of cancer in humans.

Past medical studies at the Children's Hospital Medical Center in Boston, have found that although blood vessels grow nearly everywhere in a healthy animal, cartilage resists capillary spreading. And it is capillaries that carry the nutrients and oxygen that tumors need to grow. Until blood vessels provide the tumor with these substances it seems to remain small. With the arrival of nourishment, the tumor grows rapidly. Researchers have long guessed that the tumor "asks" the capillaries to move toward it through some form of attractant. The process has been called angiogenesis.

In experiments to understand if and how cartilage retards angiogenesis Langer and Lee first used calf cartilage. Their studies brought new observations, but the required purification of the cartilage yielded only a tiny quantity of the anti-angiogenesis factor for them to work with. Looking for a more ample source, two years ago Sea Grant supported research to determine the feasibility of using shark cartilage. Cartilage composes about 6 percent of the shark's total body weight, compared to less than 0.6 percent in calves. Additionally, sharks are very large, about 10 times heavier. As an ocean resource, they are little used and abundant in many parts of the world.

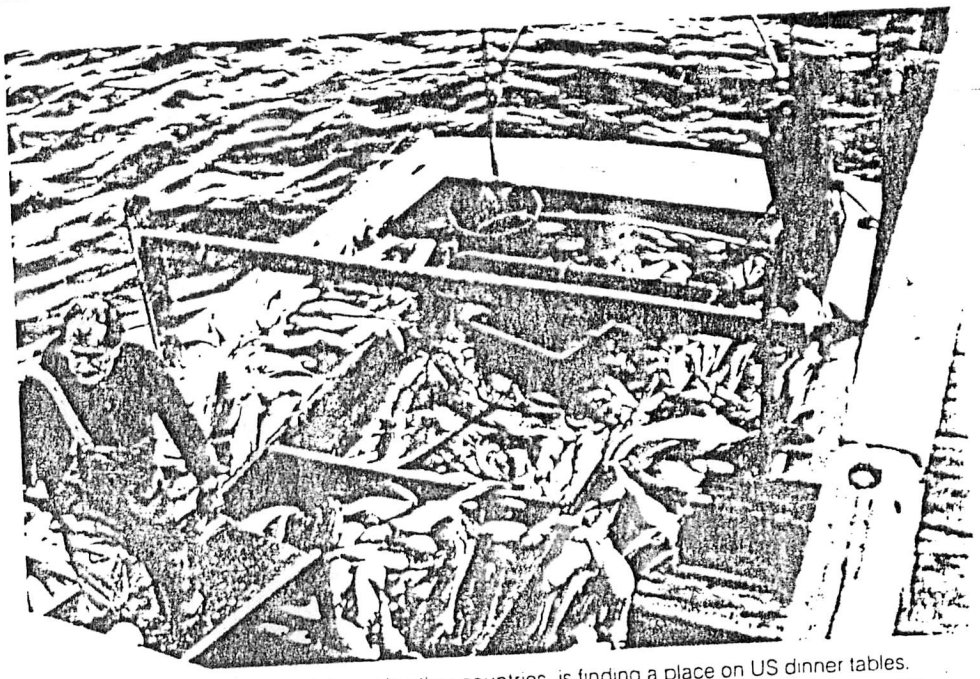


Figure 1. Shark meat, long a delicacy in other countries, is finding a place on US dinner tables. Around 60 percent of the fish becomes a seafood, but over 40 percent is thrown away as unusable. If pharmaceutical applications could be found for the now discarded cartilage, the waste would be reduced and fishermen would benefit economically.

In a year-long study, they found that the inhibiting substance was much more abundant in the shark cartilage than in that of the calves. While it takes 500 grams of calf cartilage to get one milligram of the extract, the same amount of inhibitor can be processed from one-half gram of shark. The extract also proved to be more potent and require less purification.

No one yet knows why the the shark anti-angiogenesis factor works. To gain this knowledge, the researchers need to first develop purer extracts and a method of testing that does not involve live animals. Working with live animals is costly and slow; if the same results could be achieved in a glass dish, they could reach conclusions more quickly. Like much state-of-the-art research, results will take time and infinite patience, but Langer believes the prospects are quite promising. (This story is based on an article by Julie Schecter which appeared in the MIT Industrial Liaison Program *Reports on Research*.)

Researchers Seek Improvements in Wave Modeling

The prediction of wave forces on ships and offshore platforms is an economically important but scientifically difficult problem. In a recent survey it was found that "blows by waves . . . are the most common source of heavy-weather damage to ships and that . . . catastrophic casualties to merchant vessels occurred in seaways which were . . . steep and/or confused." As one step towards improving predictions of breaking wave forces, Professor Kendall Melville and graduate student Eng-Soon Chan of the MIT Department of Civil Engineering are conducting laboratory experiments using a programmable wave generator to produce repeatable breaking waves and measure the forces imposed on prototype structures. The repeatability of the experiments permits the forces to be measured in a controlled manner for waves just before, at, and after breaking.

Melville would like the project to produce "the reference set of laboratory measurements for breaking-wave forces

Editor: Elizabeth T. Harding
Program Director: C. Chryssostomidis
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The MIT Sea Grant Quarterly Report reviews the Program's marine-related research, education, and advisory service activities at the Massachusetts Institute of Technology. Funding is provided by the National Oceanic and Atmospheric Administration through the Office of Sea Grant. Free subscriptions of the *Quarterly Report* are available on request from the MIT Sea Grant College Program, Guilding E38-302, Cambridge, MA 02139. Telephone (617)253-3461.

on structures, which would provide a reliable foundation for further theoretical and numerical modelling." He believes that they will have that set of measurements in the next year.

According to Melville, the work so far has shown that the wave pressure on a structure can rise from zero to its maximum value in milliseconds or less. In controlled laboratory experiments, the sampling system can be triggered to start a few milliseconds prior to the impact, thereby catching the full pressure field. There the randomness of the waves prevents a prediction when a wave will break against a structure, suggesting that most measurements of forces in the field are probably not done on the necessarily short timescales.

In the past, variability in generating the waves has led to variability in the measurements. By exactly reproducing the generating process, Melville and Chan reduce the ambiguity so that any lack of reproducibility in the wave pressure measurements is due to variability in the fine scale structure of the breaking process itself. In order to quantify these fine scales, the usual pressure and surface displacement (wave shape) measurements are being complemented by high speed photography and fluid velocity measurements using laser anemometry (measuring movement at an exact spot).

Melville believes that one reason why the details of the pressure field may not be reproducible is because the velocity field varies unpredictably on a very fine scale, particularly just before the breaking wave hits the structure. Wave breaking is a transition process between (predictable) laminar flow and (unpredictable) turbulent flow. Before doing theoretical and numerical modelling, the source of the variability must be isolated. One approach is to correlate the velocity and pressure measurements from test to test. If the pressures vary significantly while maintaining a significant

continued on page 4.

Undergraduate Researchers at MIT
The Great MIT Keel Haul

On September 26, 1983 the *Australian II* 12-meter sailing yacht, to the delight of those Down Under, upset the American *Liberty* in the 1983 America's Cup regatta in Newport, Rhode Island. The winning secret, a mysterious "winged" keel, supposedly reduced drag and provided extra stability for the ultimate victory.

On January 12, 1984, Halsey Herreshoff, naval architect and tactition for the defeated *Liberty*, told a group of MIT students he was confident that with a bit of R&D the U.S. could recapture the coveted Cup. Herreshoff was talking to the right crowd.

Piqued by the challenge of outmaneuvering the audacious Aussies, 20 MIT students banded together two-by-two to enter an America's Cup race, MIT style. The contest was organized by Cliff Goudey, engineer and naval architect at MIT Sea Grant, and the object was to design and construct a superior model winged keel. Entries would compete – how else? – in a computerized simulation of the famous regatta.

Unleashing uninhibited, scientific imaginations, the students concocted an unusual array of keel configurations. Designs ranged from a bulbous keel with flat, nub-like fins to a wide contraption with long, narrow fins angled at 20 and capped with tip pods. All models were constructed of "Bondo" over a standard steel skeleton.

Twelve meter rules and the test facility, MIT's Variable Pressure Water Tunnel, dictated the design parameters. Model keels, for example, could not be more than 7½ inches deep. The intersection with the hull had to be at least 10 inches long and one inch wide, and keel wings were limited to 7½ inches total width.

To determine each model's impact on vessel stability, lift, drag, and the size and vertical distribution of volume were measured in the water tunnel. This data, combined with a baseline hull and sail plan design, was furnished to MIT's Velocity Prediction (computer) Program (VPP). Developed in the Department of Ocean Engineering, VPP accurately predicts a yacht's sailing performance given wind conditions and vessel design characteristics.

The race was on.

Actually, two races were run. A standard America's Cup simulated Newport, Rhode Island wind conditions, where speeds typically increase from 8 to 20 knots during the race. Three windward, one running, and two reaching legs were used. The winning keel, designed by John Wang and Davis Pan, was a simple, tapered planform. Ironically, it had no wings: Goudey said the full benefit of keel wings may not have been realized in these conditions, since to achieve that, the entire baseline yacht should have been redesigned to take full advantage of each variation. "We were limited by time and couldn't make all possible refinements," Goudey explained.

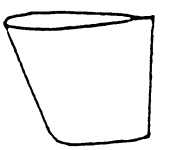
Competitors in the 1987 America's Cup in Perth, Australia, should beware of MIT students Bill Dalton and Rick Fontana. Their keel design, incorporating large, full-width fins angled down at 30 with an aft sting, took first place in the second race simulating the winds of Perth. Here, in unrelenting 24-knot gales, the extra stability afforded by heavy wings and large fins was apparent. Asked if his keel had potential for a future America's Cup, Fontana said, "Sure!" But he has no plans to sell yet.

A design by George Chyz and Jim Gottwald, with constant chord, increased lower thickness, and small fins set aft, finished a strong second in both races. "That design may be the best all-around performer," said Goudey.

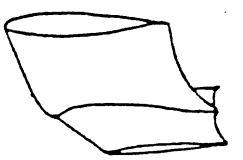
The keel haul even was offered during MIT's Independent Activities Period, a month-long program of unstructured courses, lectures, and activities presented by and for the MIT community in January each year.

One of the biggest risk-takers in the contest now has gone on to serious scientific study of the subject. John Cross' unusually innovative contest entry, with a hollow, open-ended cylindrical wing, finished poorly in the race. But with an Undergraduate Research Opportunity award (UROP) (see *Quarterly Report*, Fall-Winter 1983-84) from MIT Sea Grant, Cross is undertaking a systematic analysis of the effects of keel wings.

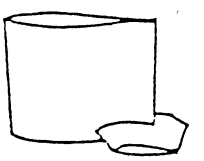
Using a "parent" keel design, he will add various wing configurations and test them in the water tunnel. If Herreshoff's prediction is true, this little bit of R&D just might inspire a U.S. victory in '87.



Wang/Pan — no fins; tapered plan form



Dalton/Fontana — large, full width fins. 30 Deg., 15% thickness; aft sting



Chyz/Gottwald — constant chord, increased lower thickness; small fins set aft

Dienes/Cross — circular foil

Figure 2. Winning keel designs

correlation with the velocity field, then the researchers will have a good idea of the source of the variability.

Waves generated in the experiments are several meters long, 10 to 20 cm high and have a typical period of about 1 second. Scaling up to likely ocean dimensions of perhaps one hundred times larger is not easy. However, in a related project, Melville and graduate student Ronald Rapp have found that by using a limited number of dimensionless parameters to describe the waves, they have been able to correlate breaking events in the laboratory. "We believe that we know now how to scale the breaking waves, which was really quite important for doing these experiments in an orderly manner," says Melville. "I am confident that we will produce scaling laws which will permit us to reliably extrapolate our measurements to full scale."

The velocities in breaking waves may be an order of magnitude larger than those in unbroken waves of the same height, so that structures in the immediate neighborhood of the surface may be subjected to higher loads more frequently than anticipated from simple breaking-criteria estimates. "That fact is not appreciated very much by wave statisticians but comes out clearly in related measurements we've been making. The conventional surface displacement measurements are really a very poor predictor of the velocity field if the waves are breaking; and waves are breaking even in the more benign sea states. There is clearly a need for an improved statistical description of the velocity field associated with the wave field."

The simplest structure used in the laboratory is a flat plate which may represent the side of a supertanker. "We intend to devise an impact algorithm to predict the pressure on the structure given the details of the waves prior to impact," says Melville. The other prototype structures are cylinders mounted with axes either vertically or horizontally.

So far the researchers have made measurements of surface displacement and pressure fields on flat plates and are about to start the numerical experiments for the forces on the flat plate. In addition, they have initiated experiments on the pressure field and total force on cylinders.

Special Events

This new column will appear in future issues when there are lectures, seminars, courses of potential interest to *Quarterly Report* readers.

COASTWEEK '84 once again offers coastal visitors and residents a chance to learn about the benefits, pleasures, and problems – past and present – of making the best use of the ocean and coastal resources. During October 7-14, and the weeks that surround it, there will be many opportunities for the public to attend lectures and special events that inform, entertain, and involve participants. On September 27 at MIT Dr. William Castelli, one of the foremost experts on heart disease and nutrition, will discuss recent research which indicates that oils in many fish have a beneficial effect on lowering undesirable cholesterol and reducing the risk of stroke-causing blood clots. In a lecture followed by a question and answer session, Dr. Castelli will talk about ways of reducing the US's high incidence of heart disease. He brings with him the perspective of 35 years of study as head of the longest continuous heart study in the world in Framingham, Massachusetts. Contact Madeleine Hall-Arber (617) 253-7041 if you wish to attend on the 27th at 7pm in the Mariar Lounge, Building 37, Room 252, MIT. Brochures are available on other COASTWEEK '84 events in Massachusetts, New Hampshire, and Maine.

Coastal Zone and Continental Shelf Conflict Resolution. November 13, 14, 15 MIT Sea Grant is sponsoring a conference to explore traditional and non-traditional methods for resolving ocean-related conflicts, such as hazardous waste disposal, offshore energy development, pollution control, and international boundary disputes. Twenty one experts will discuss complex case histories involving scientific uncertainty and disagreement for which an approach, other than expensive, time-consuming litigation, could have or still might produce better results. A look at the potential applications of alternative resolution techniques will include examinations of computer models, mini-trials, and various mediation techniques. The conference will begin the evening of November 13, with registration, a reception and a participatory exercise in which conferees will role play in a scorable game developed by Harvard Program on Negotiation.

The conference chair is J.D. Nyhart, MIT Professor of Ocean Management and sponsors include MIT Sea Grant, the MIT Department of Ocean Engineering, the William H. Donner Foundation, and the US Department of Environmental Protection. For more information, contact Elizabeth T. Harding, MIT Sea Grant, (617) 253-3461.

Farmers of the Sea. On November 13, NOVA, the award-winning science series on PBS, will present this film on aquaculture around the world. Check your local PBS schedule for time.

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Abstracts

☐ **Russian Translation: On Trawl Hydrodynamics and Hydrodynamic Water Channel for Fishing Gear Research**

Clifford A. Goudey, ed.
Center for Fisheries Engineering Research, Report 5

MITSG 83-32 7pp No charge

First in a series of MIT Sea Grant reports aimed at disseminating foreign technical work which is generally unavailable. The two translations by Leonid Pukshansky were selected for their relevance to current work being done in the U.S. On Trawl Hydrodynamics concerns extensive full-scale flow measurements in and around a midwater trawl. Research techniques used suggest the Russians have an active and well supported gear research program. The second article describes a USSR facility for hydrodynamic testing of model trawl gear.

☐ **A Pioneer Deep Ocean Mining Venture**

J.D. Nyhart, M.S. Triantafyllou
MITSG 83-14 255pp $8.00.

Using the MIT-NOAA Deep Ocean Mining Model, the authors thoroughly analyze the economic outcomes of a hypothetical pioneer deep ocean manganese nodule mining project. A detailed narrative of likely events leading to full commercial production is provided. Capital and operating costs are estimated, and assumptions necessary to the financial analysis made in the model are described. Finally, a complete financial analysis is detailed based on estimated costs, timing, regulatory policies.

☐ **An Ecodynamic Analysis of Algal Blooms Fouling Nahant Bay Beaches**

Alician V. Quinlan
MITSG 82-15 93pp $8.00

Since early 1900s, residents of Nahant and nearby communities have complained about a chronic stench emanating from a brown alga that has washed up on local beaches. This study identified the alga as an abnormal free-living form of the common, attached filamentous, *Pilayella littoralis*. The foul order is caused by anaerobic wet decomposition of the biomass, buried chiefly during the annual late-winter and early-spring natural beach build up process. The report describes the history of the problem, the research methods used to understand the growth, reproduction, and transport of the algae, and suggests short-term management and long-term research schemes.

☐ **Importance of Life Cycle Events in the Population Dynamics of *Gonyaulax tamarensis***

D.M. Anderson, S.W. Chisholm, C.J. Watras
MITSG 83-29J 12pp No charge

Life cycle changes that allow populations of the toxic dinoflagellate *Gonyaulax tamarensis* Lebour to inhabit the benthos and the plankton alternately are important factors regulating the initiation and decline of red tide blooms in embayments. Population monitoring showed that encystment contributed substantially to the decline of the vegetative cell population. The authors conclude that the encystment/excystment cycle temporarily restricts the occurrence of the vegetative population and may not be optimized for bloom formation. Factors that distinguish bloom from non-bloom years appear to be operating on the growth of the planktonic population.
Reprinted from *Marine Biology*, v.76, 1983, pp.179-189.

Enclosed: $_____

Please check off those publications you would like to order, and return this entire page – or a copy of it – to the Sea Grant Program, Massachusetts Institute of Technology, Building E38-302, Cambridge, MA 02139.

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☐ **Quantitative Geometric Characterization of Two-Dimensional Flaws via Liquid Crystals and Thermography**

J.H. Williams, Jr., B.R. Felenchak, R.J. Nagem
MITSG 84-6J 21pp $2.00.

Thermal nondestructive testing (NDT) is a technique for obtaining surface temperature profiles on a structure and subsequently relating this information to some imperfection within the structure. Liquid crystals may be used to reveal the temperature anomaly. The first paper describes experiments conducted on two specimens containing simulated machine flaws. Tests showed that the size and location of the simulated flaws can be determined to within approximately 10 percent. In the second paper, a liquid crystals kit capable of providing quantitative assessments of the structural integrity of fiberglass boats is developed.
Reprinted from Materials Evaluation, v.41, no.2, pp.190-210, 218.

☐ **Shark Cartilage Contains Inhibitors of Tumor Angiogenesis**

Anne Lee, Robert Langer
MITSG 84-8J 5pp No charge

Shark cartilage contains a substance that strongly inhibits the growth of new blood vessels toward solid tumors, thereby restricting tumor growth. The abundance of this factor in shark cartilage, in contrast to cartilage from mammalian sources, may make sharks an ideal source of the inhibitor and may help to explain the rarity of neoplasms in these animals. Reprinted from Science, v.221, September 16, 1983, pp.1185-1187.

☐ **Analysis of Manufacturing Processes of Large Anchor Chains, Phase II — Development of Strategies for Improving the Reliability to Welded Chains**

Robert J. Klimowski, V.J. Papazoglou, Koichi Masubuchi
MITSG 84-9 247pp Photocopy only available, $12.50

This document reports the results of a study aimed at developing strategies for improving the reliability of flash butt welded anchor chains. The research included a parametric study of factors affecting the quality of flash welded chains, development of strategies for in-process sensing and control of flash welding, and an effort to reduce the possibility of premature failure of a welded chain.

☐ **Hypothermia: Think Survival, Not Rescue**

Maine/New Hampshire Sea Grant College Program. 28 minutes, color, VHS ½" and ¾", $2.50 rental fee.

The videocassette is aimed at fishermen, and discusses preventive measures to protect from hypothermia in the event it is necessary to abandon ship while at sea.

☐ **Hypothermia: The Chill That Need Not Kill**

Maine/New Hampshire Sea Grant College Program. 18 minutes, color, VHS ½" and ¾", $2.50 rental fee.

Designed for those responding to situations where hypothermia may be part of the picture. Simulated accident and subsequent treatment of sub-acute hypothermia victim.
